VIRGINIA GIS REFERENCE BOOK

General Application Category/Sub Application Name: County Executive & Board of Supervisors

Product /Service/Function Name: Land Use & Development Studies

P/S/F/ Description: An application to allow county executives the ability to evaluate land use and development studies. The application would be helpful to visualize data for purposes of master planning, zoning, new and existing development studies, and change detection analysis/studies.

Product /Service/Function

1. Spatial Data:

Spatial Data is information about the location and shape of, and relationships among geographic features, usually stored as coordinates and topology. In general terms, spatial data is a term given to digital information that contains a geographic component.

The most basic format of spatial data is typically in the form of "shape" file (ESRI file format), or a DWG file (AutoCAD file format). These file formats are, for the most part, standards in the GIS industry. This spatial data can be presented within certain software packages in varying degrees of formatting, such as coverages, themes and projects. Spatial data is usually categorized in two ways. Vector spatial data are typically point, line, polyline, or polygon shapes depicting objects or features. Raster spatial data are typically imagery-based data such as orthophotography or image based generated such as digital raster graphics. Raster imagery is typically used as a base layer or frame of reference layer.

- Minimum Requirements: At a minimum, a functioning application that provides a basic level spatial data representing the boundaries of parcels, zoning and custom developed point or polygon representing propositions, issues or easements. All point and polygon data should include positional information as well as, at a minimum, a unique identifier that will link to attribute information. Additionally, a spatial raster base data layer will be needed to provide a frame of reference for the desired region. If the above spatial layers are not already compiled then they will need to created or developed using standard GIS data collection and development processes. All spatial data will need to be in the same coordinate system, projection and file formats.

- Optional Requirements: Additional spatial data layers will enhance the overall usefulness of the GIS. Optional spatial data are environmental data layers such as hypsography, hydrology, environmental boundaries, and special habitat boundaries. Other vector data are electric, water, sewer access points and lines.

Building footprint polygons could be generated instead of points. Multiple base map layers such as digital raster graphics (DRGs) from the USGS or digital elevation model graphics (DEMs) may be added as base map layers in order to convey additional information to the user.

2. Attribute Data

Attribute data are characteristics of a geographic features described by numbers, characters, images or drawings, typically stored in a tabular format and linked to the feature by a user-assigned identifier. In most basic terms attribute data are tabular data in a database structure that link to and hold additional information about corresponding spatial data.

Attribute data will generally be in two forms. One form will be tabular data in a ".dbf" file format which is a component of the ESRI shape file set. These spatial data are typically and best limited to unique identifier column and columns that hold pertinent spatial information such as lat/long information or X/Y positions. Additional attribute information should be housed in a separate typical database structure (ASCII text file, spreadsheet, database) that links to the unique identifier of the records in the shape file "dbf". These data can contain all additional information that is needed or desired to convey information about a particular spatial element. All data structures and naming conventions should be in standard ANSI formats.

- Minimum Requirements: At a minimum, typical attribute data will include boundary dimensions of the selected land use or development as well as categorical information, name and short description.
- Optional Requirements: Optional attribute information could include practically any type of information that could be relevant to land use development analysis or study. Some examples would include flood zones, greenways, environmental easements, conservatory easements, ownership information, and tax base information.

3. Data Acquisition Options (integrated with VBMP digital orthos):

The majority of spatial data acquisition will typically be completed in the form of parcel maps, zoning maps, or flood maps. Additional spatial data collection will be performed utilizing fieldwork with field personnel and GPS units. For most localities attribute data collection will begin with a download or export from existing datasets such as tax assessment records, special use permits, development records and so on. Where possible, acquiring data that has already been developed will be the desired model. In many cases the spatial data may come from a landscape architect firm or the local engineer's office.

The VBMP digital orthophotography will be one of the best sources for the spatial base map layer. This will be available through arrangements with the Virginia Geographic Information Network. Other possible base map layers may include raster spatial data from the VEDP and USGS.

4. Data Conflation Options (integrated with VBMP digital orthos):

Conflation is the method whereby a geographic feature is adjusted to fit a more accurate base map. This process can occur in variety of ways, with the least sophisticated being a "best-fit" methodology. The best-fit method is a visual inspection or comparison of a geographic feature's current position to where it is or should be located on the more accurate base map.

Another conflation option includes rubber sheeting, a method using control points or existing boundaries to establish the new geographic position of a feature. Finally, the most accurate method of conflating data includes the use of Global Positioning Satellite technology (GPS), or traditional survey instruments to accurately locate an objects physical location.

5.GUI / Programming Options:

A GUI or graphical user interface is a graphical method of controlling how a user interacts with a computer to perform various tasks. Instead of issuing commands at a prompt, the user performs desired tasks by using a mouse to choose from `a dashboard' of options presented on the display screen. These are in the form of pictorial buttons (icons) and lists. Some GUI tools are dynamic and the user must manipulate a graphical object on the screen to invoke a function; for example, moving a slider bar to set a parameter value (e.g., setting the scale of a map).

There are two main avenues to develop an application and GUI for your GIS data. An application can be standalone or distributed.

Standalone applications are typically built by programming modules, scripts and add-ins to perform specific analyses that are extensions of desktop GIS software packages such as ArcView, ArcInfo or AutoCAD.

Another desktop method would be to program a GUI and application from scratch utilizing a programming language and suite such as MS Visual Basic, FoxPro or C++ and a third party GIS programming suite such as ESRI Map Objects. Workstation based or stand-alone applications are usually developed to perform specific higher-end functions for a user that has a working knowledge of GIS systems.

Typically a distributed application will be shared across an Intranet or the Internet with the user utilizing a thin client such as a browser. An Internet based application will typically utilize a mix of languages to create a finished product. These languages can include HTML, Java, JavaScript, XML, AXL, Pearl, PHP, JSP, Cold Fusion or MS ASP. Specific knowledge a map server software package such as ESRI's ArcIMS or Autodesk's Mapguide will be required.

The application should give the user the ability to rapidly assess geographic data/map information to help determine various uses for lands or developments within a locality. The application should give the user complete control to the view attributes of various spatial data layers within the map window. The application should give the user the ability to perform custom on-the-fly color ramping and thematic mapping based on predetermined values in the attribute table across all layers. The application should give the user the ability to create annotations (labels, points, symbols, lines and polygons) on the map window and then retrieve information from attribute tables that are affected by digitized objects. Mapping interface should incorporate a change detection function.

6. Internet Functionality and Options

Internet delivery would be useful for sharing information across local departments. It would also be useful for presenting and distributed proposals and plans to various groups. Also, administrators could use the application to develop maps for proposed new facilities that could be printed and distributed at meetings. Internet functionality should include basic GIS functions available in a thin client GIS application, such as ESRI's ArcExplorer (i.e. Zoom In, Zoom Out, Pan, Identify, Query, etc.).

Additional functionality may include appropriate hyperlinks to critical and related information on the Internet related to certain queries or operations within the application. A dedicated "needs based" approach to determine user interface options and functionality is highly recommended before actual application work is to begin. There are many Internet based map server technologies available on the market today and great care should be taken to evaluate the different options when selecting the software and programming language option that will be utilized for your application.

7. Technical Requirements

Technical requirements will vary greatly depending on whether the application programming, development and hosting functions are in-house or if the functions are outsourced to a GIS applications development and hosting firm. Obviously, the situation that would require the least amount of technical requirements and resources would be to outsource to a firm that already has all the technical requirements and experience in place. However, for the purposes of this paper, we will assume that all of the development and hosting will occur in-house. Some of the resources listed below may already be within the existing pool of resources at some organizations.

- Minimum: A Basic working knowledge of a leading GIS software, and Internet Browser are required. A Pentium III or greater CPU, with a minimum of 128MB Ram, 16MB Video Card, is required. A higher speed Internet connection is recommended for GIS Internet application deployment and analysis. Most leading GIS software is customizable using MS Visual Basic or other common language. It is suggested that the developer have a working knowledge of (at least) Visual Basic before attempting GUI development.

- Optimum: In the case where a local government employs a highly capable information Technology Department, other languages may be considered, such as JSP, Java, Visual Basic, ASP, and Cold Fusion. In most cases, these languages are related to Internet application development. A web developer with three years of experience should be able to customize and/or develop a unique Internet Map Server application.

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8. Administrative / Management Requirements

Management concerns will involve technical support, system maintenance and, of course, human resource management issues of a technical product. These issues are minimized if the maintenance and/or hosting of the application are contracted to a GIS application development and hosting organization. Technical and administrative issues become more critical and consuming when developing. and/or hosting an application in-house. General expertise in GIS is suggested if outsourcing application development and hosting. In-house application development and hosting will require GIS specialist human resources, advanced web programming human resources, and significant technical material resources (hardware/software).

9. Cost – Cost/Benefit

The cost of developing a demographic analysis application, assuming that all hardware, software and human resources are dedicated to this project, could be in the $50,000 – $60,000 range. Ongoing costs could be in the $18,000 range. This could be considerably less if some portion of the resources listed below are already acquired and not at full resource capacity. Other factors affecting cost will be desired functionality, planned use, and outsourcing options involved. See below for an approximate and general breakdown of costs that may be incurred when developing an application in-house. Please note that the figures below are very general and basic estimations.

Hardware Costs: (Assuming Internet Deployment)

Item	**Units**	**Cost**	**Total**
Development Server	1	2,500	2,500
Production Server	1	5,000	5,000
GPS Units	3	1,000	3,000
Back-up System	1	3,500	3,500
Router	1	2,500	2,500
CSU/DSU	1	500	500
Dedicated Bandwidth	12	1,000	12,000
UPS for Computers	2	250	500
Total			**29,500**

Software Costs: (Assuming single processor based licensing)

Item	Units	Cost	Total
Operating System	1	1,000	2,500
Database Server	1	4,500	4,500
Map Server	1	7,500	7,500
Application Server	1	1,500	1,500
Java Server	1	1,000	1,000
Desktop GIS Package	2	1,500	3,000
Program Editor	1	650	650
Total			**20,650**

In-House Development Human Resource Costs:
(Assuming Internet Deployed Application and 6 month development cycle)

Item	Man/Hours	Utilization over 6 months	Hourly Cost	Total
GIS Specialist/Technician	75	35%	17.5	1,313
Field Personnel/Research	125	24%	15	1,875
Network/System Admin/DBA	50	24%	25	1,250
Programmer(s)	350	100%	35	12,250
Manager	50	14%	25	1,250
Total[1]				**15,928**

On-going Application Maintenance/Enhancements (after development):
(Assuming Internet Deployed Application over 12 months)

Item	Man/Hours	Utilization over 6 months	Hourly Cost	Total
GIS Specialist/Technician	25	15%	17.5	438
Network/System Admin	25	7.5%	25	625
Programmer(s)	120	22%	35	4,200
Manager	25	7.5%	25	625
Total[1]				**5,888**

On-going Application Hosting (after development):
(Assuming Internet Deployed Application over 12 months)

Item	Units	Unit Cost	Total
Dedicated Bandwidth	12	1,000	12,000
Total			**12,000**

[1] Please note that the above human resources are rough estimates of hours for man-hours needed to perform some data collection and data development processes as well as the application development process. If the above human resources are not currently on staff and available for a project of this nature, resources would need to be acquired, most likely on a full-time basis. This is not feasible unless there is sufficient cause and workload to occupy these human resources for the additional hours above the utilization column above.

As indicated from the above estimates, developing the initial application could range in the $60,000 range. On-going maintenance, enhancements and hosting could be in the $18,000 range. Outsourcing the development and hosting functions to a qualified/experienced applications development firm could realistically cut the initial development costs by 50% and cut the ongoing maintenance and hosting costs by 75%.

The cost/benefit is highly favorable. The benefit to county executives and board of supervisors is somewhat intangible, yet positive in the form of providing improved public and business services, providing better decision making information and possibly allowing for quicker resolution of some issues. The fact that county executives are utilizing technology and GIS to be better informed will most likely increase or initiate a positive perception of their abilities.

9. Standards / Guidelines Summary

All GIS or spatial data should be delivered, collected or developed in a format and projection that matches the VBMP orthophoto base map. The attribute, or tabular data, provided by 3rd party entities should be in a standard database format, spreadsheet format or ASCII delimited text file format.

When and where possible, approach the application development process in phases. This type of application will be very data centric or rely on data a great deal for usefulness to the intended user. Develop a basic database application as a first step and then add the mapping functionality and administrative and "back-end" functions in a later phase. This process will help keep the project manageable and allow for dispersed budgeting.

As with most all data, providing a source for the information portrayed as well as including disclaimer information is highly recommended.

11. Startup Procedures/Steps

- Application Outline / Blueprint: Application purpose, interface design, functionality, queries and "look and feel" should be determined and documented as an initial step. Stakeholders should be involved in this step.

- Data Acquisition: The attribute data should be obtained from the various sources mentioned earlier and normalized and related where necessary. Spatial data can be downloaded from a variety of sources listed above. If spatial data is not available then it will need to be collected and developed.
- Sourcing Determination: Determine entity/entities that will be performing data development functions, application development functions and application hosting functions and create a project plan with budget numbers.
- Develop a implementation plan that includes timelines and milestones.
- Develop a data development/transformation plan that includes metadata definitions, database schema, and data dictionaries with relational information.
- Readdress your project plan, timelines and budgets as a final initial process before committing resources.
- It is recommended that the database application functions be addressed and implemented before the mapping functions.

12. Estimated Time Line and/or Implementation (stand alone) schedule

The estimated time to develop this application varies based on functionality. This can be as little as two months, to as much as six months. Typically this type of application can be developed in approximately three months. Data collection and development functions will add to the timeline. A sample timeline may if offered below as a generic applications development cycle.

Function	**Time**
Data collection/Research	1 months
Data development	1 month
Application Planning/Documentation	1 month
Application development	3 months
Application staging/testing	1 month
Total time line	**6 months**

13. Best Practice Example in Virginia:
None